

Claims filed 4/13/04, renumbered
per Rule 1.126

CLAIM AMENDMENTS

Please cancel claims 1 – 64, 76 and 77 as shown in the complete list of claims below.

1 – 64 Cancelled

39 ~~68~~. (Original) A system comprising:

a traction unit operable to traverse a surface;

a tether attached to the traction unit and operable to suspend the traction unit should the traction unit fall; and

a boom attached to the tether and operable to suspend the tether.

40 ~~68~~. (Original) The system of claim ³⁹~~65~~ wherein the traction unit comprises:

a frame;

a plurality of drive wheels attached to the frame and operable to propel the frame across a surface;

a plurality of adherence members attached to and movable relative to the frame and operable to releasably secure the frame to the surface, each adherence member including an adherence foot attached to a body that is operable to extend the adherence foot toward the surface and retract the adherence foot from the surface; and

a plurality of return mechanisms attached to the frame and each operable to move a respective adherence member to a respective return position when the body retracts the adherence foot from the surface.

41 ~~67~~. (Original) A system comprising:

a first traction unit operable to traverse a surface;

a second traction unit operable to traverse a surface; and

a tether attached to the first and second traction units and operable to suspend the first or second traction unit from the second or first traction unit should the first or second traction unit fall.

42 ~~68~~. (Original) The system of claim ~~67~~⁴¹ wherein the tether is rigid.

43 ~~69~~. (Original) The system of claim ~~67~~⁴¹ wherein each traction unit comprises:

a frame;

a plurality of drive wheels attached to the frame and operable to propel the frame across a surface;

a plurality of adherence members attached to and movable relative to the frame and operable to releasably secure the frame to the surface, each adherence member including an adherence foot attached to a body that is operable to extend the adherence foot toward the surface and retract the adherence foot from the surface; and

a plurality of return mechanisms attached to the frame and each operable to move a respective adherence member to a respective return position when the body retracts the adherence foot from the surface.

44 ~~70~~. (Original) An adherence foot comprising:

a backing plate; and

a first annular lip defining a first inner cavity and operable to form a seal when the lip contacts a surface;

a second annular lip defining a second inner cavity that includes the first annular lip and first inner cavity and operable to form a seal when the second annular lip contacts a surface.

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- 45 ~~71~~. (Original) The adherence foot of claim ~~70~~ wherein the backing plate includes a vacuum port operable to connect the first inner cavity with a vacuum source.
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- 46 ~~72~~. (Original) The adherence foot of claim ~~70~~ further comprising a soft viscous material disposed in a lip chamber located between the first annular lip and the second annular lip and operable to protrude from the lip chamber when the first and second lips are forced towards the surface.
- 44
- 47 ~~73~~. (Original) The adherence foot of claim ~~70~~ further comprising a third annular lip defining a third inner cavity that includes the first and second annular lips and the first and second inner cavities and operable to form a seal when the third annular lip contacts a surface.
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- 48 ~~74~~. (Original) The adherence foot of claim ~~70~~ further comprising:
- a third annular lip defining a third inner cavity that includes the first and second annular lips and the first and second inner cavities and operable to form a seal when the third annular lip contacts a surface; and
 - a soft viscous material disposed in a lip chamber located between the second annular lip and the third annular lip and operable to protrude from the lip chamber when the second and third lips are forced towards the surface.
- 49 ~~75~~. (Original) A truck comprising:
- a motor;
 - a truck body;
 - a bogie assembly attached to the truck body and including a retractable bogie, a drive wheel and a belt attached to the bogie and drive wheel, wherein the bogie assembly is operable to suspend a portion of the belt away from the surface and is operable to force a portion of the belt against the surface.

a drive shaft disposed within the truck body and attached to the motor and operable to transmit the power generated by the motor to the drive wheel; and

a steering sprocket attached to the truck body and operable to rotate the truck body;

76. - 77. Cancelled (don't exist)

50 78. (Original) A method of traversing a surface, comprising:

attaching an adherence foot to the surface;

pulling a frame with a drive wheel against the surface by pulling the adherence foot and frame toward one another;

moving the frame relative to the attached adherence foot;

releasing the adherence foot from the surface; and

returning the released adherence foot to a return position.

51 79. (Original) The method of claim ⁵⁰ 78 wherein attaching an adherence foot includes generating a vacuum between the adherence foot and the surface.

52 80. (Original) The method of claim ⁵⁰ 78 wherein releasing the adherence foot from the surface includes generating air pressure greater than atmospheric pressure between the adherence foot and the surface to blow the adherence foot from the surface.

53 81. (Original) The method of claim ⁵⁰ 78 wherein moving the frame relative to the attached adherence foot includes moving the frame relative to a body of a respective adherence member.

54 82. (Original) The method of claim ⁵⁰ 78 wherein:

moving the frame relative to the attached adherence foot includes moving the frame relative to a respective body; and

releasing the adherence foot from the surface occurs before the respective body contacts a hard limit that prevents the frame from moving relative to the body.

55 83.

⁵⁰
(Original) The method of claim ~~78~~:

wherein moving the frame relative to the attached adherence foot includes moving the frame relative to a respective body; and

further comprising stopping the frame from moving relative to the attached adherence foot when a respective body contacts a hard limit and the adherence foot remains attached to the surface.

56 84.

⁵⁰
(Original) The method of claim ~~78~~ wherein moving the frame relative to the attached adherence foot includes:

moving the frame relative to a respective body; and

crossing with the respective body a soft limit that signals the location of the frame relative to the body before the body contacts a hard limit.

57 85.

⁵⁰
(Original) The method of claim ~~78~~ wherein:

moving the frame relative to the attached adherence foot includes moving the frame relative to a respective body; and

releasing the adherence foot from the surface includes releasing the adherence foot after the respective body crosses a soft limit but before the adherence member contacts a hard limit.

58 86.

(Original) A method of attaching an adherence foot to the surface comprising:

contacting the surface with two or more annular lips of an adherence foot; and

generating an attachment force in the adherence foot.

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59 87. (Original) The method of claim ~~86~~ wherein contacting the surface with the adherence foot includes contacting the surface with three annular lips.
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60 88. (Original) The method of claim ~~86~~ wherein generating an attachment force between the adherence foot and the surface includes generating a vacuum between a suction cup and the surface.
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61 89. (Original) The method of claim ~~86~~ wherein generating an attachment force in the adherence foot includes:

pumping air out of an inner cavity in a suction cup with a vacuum source connected to the suction cup; and

forming an air-tight or substantially air-tight seal between one or more annular lips and the surface.

- 58
62 90. (Original) The method of claim ~~86~~ further comprising maintaining an attachment force in the adherence foot that includes:

forming an air-tight or substantially air-tight seal between the surface and a first annular lip that defines a first inner cavity; and

forming an air-tight or substantially air-tight seal between the surface and a second annular lip that defines a second inner cavity including the first annular lip and first inner cavity, wherein if the second annular lip can not form or loses an air-tight or substantially air-tight seal, a vacuum in the first inner cavity is not destroyed.

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63 91. (Original) The method of claim ~~86~~ further comprising releasing the adherence foot from the surface that includes generating air pressure greater than atmospheric pressure between a suction cup and the surface to blow the suction cup away from the surface.

- 64 92. (Original) A method of attaching an adherence foot to the surface comprising:

determining the orientation of an adherence member relative to the direction of gravity;

generating an attachment force in the adherence foot; and

adjusting the attachment force in the adherence foot based on the direction of gravity.

65 93. (Original) The method of claim ⁶⁴92 wherein generating an attachment force includes generating a vacuum between a suction cup and the surface.

66 94. (Original) The method of claim ⁶⁴92 wherein generating an attachment force includes generating a vacuum between a suction cup and the surface and adjusting the attachment force includes adjusting the vacuum based on the direction of gravity.

67 95. (Original) A method of pulling the frame toward the surface comprising:

determining the orientation of an adherence member relative to the direction of gravity;

generating a retraction force in the adherence member; and

adjusting the retraction force in the adherence member based on the direction of gravity.

68 96. (Original) The method of claim ⁶⁷95 wherein generating a retraction force includes generating pressurized air in the adherence member.

69 97. (Original) The method of claim ⁶⁷95 wherein generating a retraction force includes generating pressurized air in the adherence member and adjusting the retraction force includes adjusting the air pressure generated in the adherence member based on the direction of gravity.

70 98. (Original) A method of releasing a plurality of adherence feet attached to a surface comprising:

selectively attaching one or more adherence feet to a surface; and

selectively releasing one or more attached adherence feet from the surface while maintaining at least one adherence foot attached to the surface at all times.

71 99. (Original) The method of claim ⁷⁰~~98~~ wherein selectively releasing one or more attached adherence feet from the surface includes releasing the adherence feet attached to respective adherence members that contact respective hard limits established on the frame.

72 100. (Original) The method of claim ⁷⁸~~98~~ wherein selectively releasing one or more attached adherence feet from the surface includes:

releasing the adherence foot attached to a respective adherence member that is the first in time to cross a respective soft limit established on the frame;

and

then releasing the adherence foot attached to a respective adherence member that is the second in time to cross a respective soft limit.

73 101. (Original) The method of claim ⁷⁰~~98~~ wherein selectively releasing one or more attached adherence feet from the surface includes:

releasing all adherence feet attached to respective adherence members that contact respective hard limits;

then releasing the adherence foot attached to a respective adherence member that is the first in time to cross a respective soft limit; and

then releasing the adherence foot attached to a respective adherence member that is the second in time to cross a respective soft limit.

74 102. (Original) The method of claim ⁷⁰~~98~~ further comprising determining whether the release times of all the adherence feet are converging to one point in time.

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75 ~~103~~. (Original) The method of claim ~~98~~ further comprising determining whether the release times of all the adherence feet are converging to one point in time and, wherein selectively attaching one or more adherence feet to the surface includes selectively pausing temporarily the attachment to the surface of at least one of the one or more adherence feet.

76 ~~104~~. (Original) A method of turning a wheel traversing on a surface comprising:
moving a wheel out of contact with the surface;
turning the wheel while the wheel is out of contact with the surface; and
moving the wheel into contact with the surface.

77 ~~105~~. (Original) The method of claim ~~104~~ wherein moving the wheel away out of contact with the surface includes pushing a frame away from the surface.

78 ~~106~~. (Original) A method of traversing an obstruction on a surface comprising:
sensing the obstruction;
lifting a bogie of a bogie assembly higher than the obstruction;
contacting the obstruction with a belt of the bogie assembly; and
powering a drive wheel along the belt while the belt contacts the obstruction.

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What is claimed is:

1. A traction unit, comprising: all the subsystems
a frame;
5 a plurality of trucks attached to the frame and operable to propel the frame
across a surface;
a plurality of adherence members attached to and movable relative to the
frame, and operable to releasably secure the frame to the surface,
each adherence member including a foot attached to a body that is
10 operable to extend the foot toward the surface and retract the foot from
the surface; and
a plurality of return mechanisms attached to the frame and each operable
to move a respective adherence member to a respective return
position.
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2. The traction unit of claim 1 wherein to maintain the frame a constant or
substantially constant distance away from the surface.
3. The traction unit of claim 1 further comprising a control unit coupled to the
20 adherence members and return mechanisms and operable to instruct the adherence
members to extend and retract their feet and to instruct the return mechanism to
move the adherence members.
4. The traction unit of claim 1 further comprising a control unit coupled to the
25 adherence members and return mechanisms and operable to automatically instruct
the adherence members to extend and retract their feet and to automatically instruct
the return mechanisms to move the adherence members.
5. The traction unit of claim 1 wherein the frame includes two portions pivotally
30 attached to each other.
6. The traction unit of claim 1 wherein the frame includes two portions each
having a center axis and pivotally attached at their center axes.

7. The unit of claim 1 wherein:
the frame includes two portions equal or substantially equal in size and
pivotaly attached to each other, and each portion includes two sections
5 equal or substantially equal in size; and
a respective truck, adherence member, and return mechanism are
attached to each section.
8. The traction unit of claim 1 wherein the frame includes four quadrants and
10 each truck and each adherence member is located within a respective one of the
quadrants.
9. The traction unit of claim 1 wherein:
the frame includes two portions equal or substantially equal in size and
15 pivotaly attached to each other, each portion includes two sections
equal or substantially equal in size and each section includes an
outside corner and a center;
a respective truck is located at each outside corner; and
a respective adherence member is located at each center.
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10. The traction unit of claim 1 wherein the frame is rectangular.
11. The traction unit of claim 1 wherein:
the frame includes two portions equal or substantially equal in size and
25 pivotaly attached to each other, each portion includes two outside
corners and an interior;
a respective truck is located at each outside corner; and
two respective adherence members are located in each interior.
- 30

12. The traction unit of claim 1 wherein:

the frame includes two portions equal or substantially equal in size and
pivotaly attached to each other, each portion includes two outside
corners and an interior;

5 a respective truck is located at each outside corner; and
three respective adherence members are located in each interior.

13. The traction unit of claim 1 wherein each truck is rotatably attached to the
frame.

10

14. The traction unit of claim 1 wherein each truck extends away from the frame
in the same direction.

15. The traction unit of claim 1 wherein each truck includes two wheels operable
15 to contact and roll over the surface.

16. The unit of claim 1 wherein each truck includes:

a truck body attached to the frame;
an axle attached to the truck body; and
20 two wheels attached to the axle.

17. The unit of claim 1 wherein each truck includes:

a truck body attached to the frame;
an axle attached to the truck body;
25 two wheels attached to the axle; and
a motor connected to the wheels and operable to drive the wheels.

18. The traction unit of claim 1 wherein the adherence members are operable to
increase the distance of the frame from the surface.

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19. The traction unit of claim 1 wherein the frame includes a plurality of linear
bearings each corresponding to a respective adherence member and operable to
allow movement of the adherence member relative to the frame.

20. The traction unit of claim 1 wherein the adherence member is operable to pull the frame to the surface by applying a retracting force to the foot while the foot is attached to the surface.

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21. The traction unit of claim 1 wherein the body includes an actuator having a rod that includes a first end protruding from the body and attached to the foot.

22. The traction unit of claim 1 wherein:

10 the foot includes a suction cup operable to generate a vacuum between the cup and the surface, and the body includes an actuator having a rod that includes a first end protruding from the housing and attached to the suction cup.

15 ²³ 23. The traction unit of claim 1 wherein each adherence member is movable within a translation zone.

20 ²⁴ 24. The unit of claim 1 wherein the frame includes four translation zones each having limits, and a respective adherence member is movable within the translation zone.

25 ²⁵ 25. The unit of claim 1 wherein the frame includes four translation zones each having a soft limit, and a respective adherence member is movable within the translation zone.

26 ²⁶ 26. The unit of claim 1 wherein the frame includes four translation zones each having a center, a hard limit and a soft limit half the distance between the center and the hard limit, and a respective adherence member is movable within the translation zone.

30 ²⁷ 27. The unit of claim 1 wherein each adherence member is movable within a translation zone that includes a center, and the return position is located at the center of the translation zone.

28 33. The traction unit of claim 1 wherein each return mechanism is operable to pull the adherence member to the return position.

529 34. The traction unit of claim 1 further comprising:
a control unit coupled to the adherence members and return mechanisms;
and

wherein:

10 the frame includes a sensor that defines a soft limit within a translation zone and is operable to signal the location of the adherence member to the control unit when the adherence member crosses the limit, and the control unit responds to the signal by instructing the adherence member to release the surface.

15 30 35. The traction unit of claim 1 further comprising a control unit coupled to the adherence members and return mechanisms wherein the control unit instructs each return mechanism to move the corresponding adherence member to the respective return position, and after a predetermined duration instructs the return mechanism to stop moving the corresponding adherence member.

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31 36. The traction unit of claim 1 further comprising a steering mechanism operable to rotate the trucks.

32 37. The traction unit of claim 1 further comprising a steering mechanism operable
25 to rotate each truck independent of the other trucks.

33 38. The traction unit of claim 1 further comprising two steering mechanisms and wherein the frame includes:
two portions equal or substantially equal in size and pivotally attached to each other, each portion includes two sections equal or substantially equal in size
30 and each section includes an outside corner that locates one truck, and

wherein one of the steering mechanisms is operably connected to the trucks in one portion and the other steering mechanism is operably connected to the trucks in the other portion.

5 ³⁴ ~~30~~. The traction unit of claim 1 wherein the foot includes a suction cup operable to create a vacuum between the surface and the cup, and the control unit is operable to determine an orientation of the adherence members relative to a gravitational field and adjust the vacuum of the suction cup to compensate for the orientation.

10 ³⁵ ~~40~~. The traction unit of claim 1 wherein the adherence member is operable to pull the frame to the surface by applying a retracting force to the foot while the foot is attached to the surface, and the control unit is operable to determine an orientation of the adherence members relative to a gravitational field and adjust the retraction force applied to the foot to compensate for the orientation.

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³⁶ ~~41~~. A method of traversing a surface, comprising in the following order:
attaching a foot to the surface;
pulling a frame against the surface by pulling the foot and frame toward
one another;
20 moving the frame relative to the attached foot;
releasing the foot from the surface; and
moving the released foot to a return position.

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37 ~~42~~. The method of claim ~~41~~ further comprising pulling the frame against the
25 surface by pulling an attached foot and the frame toward each other at all time while the frame traverses the surface.

³⁶
³⁶ ~~43~~. The method of claim ~~41~~ wherein attaching the foot to the surface includes generating a vacuum between the foot and the surface.